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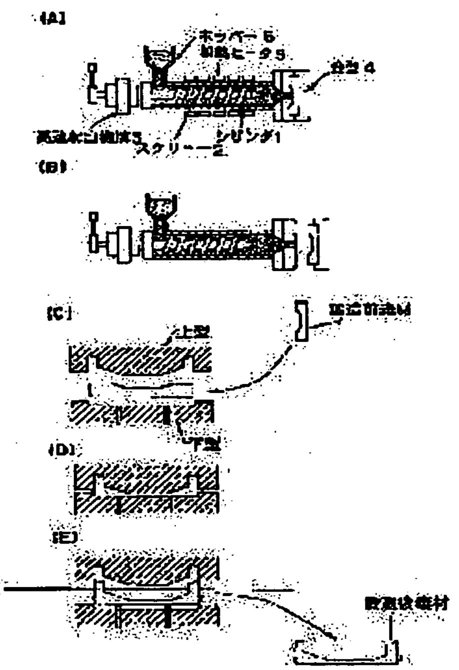
(54) MATERIAL FOR PLASTIC WORKING LIGHT METAL ALLOY AND MANUFACTURE OF PLASTIC WORKING MEMBER



(57)Abstract:
PROBLEM TO BE SOLVED: To provide a method for obtaining a forging molding by forging in only one step; wherein the light metal alloy under a semi-molten condition coexisting the solid/liquid phases with a solid phase ratio of a specific value or less or under a molten condition at the temperature right above the melting point, is injection molded so as to improve the moldability of the injection molding member of the light metal alloy.
SOLUTION: For manufacturing the material for plastic working light metal alloy, a source tip is inserted into a hopper 6, forwarded in a cylinder 1 by a screw 2, heated by a heater 5, and injected to a die 4 with a high frequency injection mechanism 3. After the mold release, the preformed material is taken out, and is taken out again after forging to be a forged material. At that time, after the light metal alloy is made under the semi-molten condition of 20% or less solid phase ratio coexisting the solid/liquid phases or the molten condition at the temperature right above the melting point, it is injection molded. Furthermore, the material being plastic worked is heat treated. The average grain size of the liquid phase is 300 μm or less under the semi-molten condition. The temperature for forging is 400° C or less. The light metal alloy contains Mg as a base metal and 4-9.5 wt.% Al as an alloy component.

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CLAIMS

[Claim(s)]
[Claim 1] The manufacture technique of the material for light metal alloy plastic working characterized by carrying out injection molding after making a light metal alloy into the melting status at the temperature of the half-melting status that the solid phase/liquid phase of 20% or less of the rates of solid phase live together, or melting point right above.
[Claim 2] The manufacture technique of the material for light metal alloy plastic working which carries out injection molding and is characterized by carrying out plastic working after making a light metal alloy into the melting status at the temperature of the half-melting status that the solid phase/liquid phase of 20% or less of the rates of solid phase live together, or base material melting point right above.
[Claim 3] Furthermore, the manufacture technique according to claim 1 or 2 characterized by heat-treating.
[Claim 4] The manufacture technique according to claim 1 to 3 that the solid phase mean particle diameter in the half-melting status is 300 micrometers or less.
[Claim 5] The manufacture technique according to claim 2 that plastic working is a forging.
[Claim 6] The manufacture technique according to claim 5 that forging temperature is 400 degrees C or less.
[Claim 7] The manufacture technique according to claim 1 to 6 that a light metal alloy uses a base material as magnesium, and contains 4 - 9.5 % of the weight of aluminum as an alloy content.
[Claim 8] The manufacture technique according to claim 3 that heat treatment conditions are T6 processings.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] this invention relates to the manufacture technique of the material for plastic working of a light metal alloy, especially the Magnesium alloy which contains aluminum as an alloy content, and the plastic-working material using it.
[0002]
[Description of the Prior Art] The light metal alloy which uses aluminum or magnesium as a base material, especially the Magnesium alloy which makes aluminum an alloy content are lightweight, and attracts attention by performing plastic working, such as forging, as a material which can secure a predetermined mechanical strength. However, by the gravity casting, since the **** injury of this seed light metal alloy is good, if casting temperature is not made high, a fluidity gets worse and a healthy (there are few cavities) casting is not obtained. However, if casting temperature is high, since a cooling rate will become small, a material organization becomes coarse, a moldability is bad and a large working ratio cannot be taken. Therefore, in order to obtain the mold goods of a demand configuration, it is necessary to repeat a manipulation repeatedly. on the other hand — although a detailed organization is obtained in a dies casting — metal mold — in order to carry out the pressure injection of the molten metal inside at the shape of mist, many minute holes in a casting are included, and serve as a gas defect, and good forging material is not obtained
[0003]
[Problem(s) to be Solved by the Invention] In order to raise such forging nature in the light metal alloy which uses aluminum and ********** as a base material, it is necessary to obtain the casting which has a detailed organization by technique other than a dies casting. Then, zealously, when injection molding was carried out as a result of the research, having adopted the half-melting injection-molding method and adjusting the rate of solid phase, or solid phase particle size, it found out that the material with a sufficient moldability was obtained and the mold goods of a request of injection-molding material with 1 from forging could be obtained.
[0004] That is, the 1st purpose of this invention is to offer the half-melting injection-molding technique of manufacturing the material which is excellent in plastic-working nature. It is in the 2nd purpose of this invention offering the technique of carrying out injection molding of the material which is excellent in plastic-working nature, and manufacturing forging mold goods with forging at one process.
[0005]
[Means for Solving the Problem] In order to attain the above-mentioned purpose, this invention is in the manufacture technique of the material for light metal alloy plastic working characterized by carrying out injection molding, after making a light metal alloy the melting status at the temperature of th half-melting status that the solid phas /liquid phase of 20% or less of the rates of solid phase live together, or base material melting point right above.
[0006] According to this invention, it is found out by making the rat of solid phase into 20% or less that the good moldability of 70% or more of the rates of a marginal **** lump is obtained (refer to the drawing 1). If it is made to perform injection molding right above [base material

melting point] even when not only the half-melting status but all are in the melting status, it is found out that the material in which a moldability excels a dies casting can be obtained.
[0007] The ground for making the rate of solid phase into 20% or less is that the solid phase mean particle diameter in the half-melting status becomes small, and the moldability of the solid phase mean particle diameter of injection-molding material improves as the parvus so that th rate of solid phase is low. If it sees from a solid phase mean particle diameter, it is found out that it is desirable that it is 300 micrometers or less, and the rate of a marginal **** lump falls abruptly bordering on it (refer to the drawing 2).
[0008] Although the liquid phase section serves as a detailed organization with injection molding in the half-melting status in the rate of solid phase although the ground which shows a good moldability with 20% or less of injection molding is not certain, and the moldability at the time of forging has the above-mentioned good injection-molding object, the solid phase section tends to hold the gestalt. Therefore, there are too many rates of a solid phase fraction, or if particle size is too large, heterogeneity will arise in a moldability, and it is thought that reducing the moldability as whole involves.
[0009] Since plastic-working nature of the material fabricated by this invention, i.e., forging nature, improves, it can perform a forging below 400 degrees C. Thereby, an intensity improves. Moreover, since the product of a network shape is made by one forging in addition to injection molding, two or more forging dies and cuttings become unnecessary, and the advantage of excelling in economical efficiency can be acquired.
[0010] It is desirable to apply this invention technique to what a base material is magnesium and contains 4 - 9.5 % of the weight of aluminum as an alloy content as a light metal alloy. It is because a fall of a moldability (rate of a marginal **** lump) is remarkable at less than 4 % of the weight when reinforcement of the mechanical strength by heat treatment cannot be desired but 9.5 % of the weight is exceeded (refer to the drawing 3).
[0011] As for the light metal alloy obtained by this invention, it is desirable to perform T6 heat treatment (solution treatment and artificial-aging-ized processing) as heat treatment conditions. Consequently, the residual strain at the time of forging is removed, and the secular change of a product configuration do not happen, but the further excellent ductility is given.
[0012] According to this invention, the injection-molding material which excels continuous casting in a moldability can be offered. Since injection-molding material is the billet of a rough-forging configuration, it can be used as a final product with forging at one process, and can cut down the number of forging processes. Moreover, since the few healthy organization of a cavity is obtained, enhancement in the yield can be aimed at.
[0013]
[Embodiments of the Invention] Hereafter, the gestalt of operation of this invention is explained, referring to a drawing. Magnesium alloys A and B which have the following composition were prepared, and injection molding was performed to the bottom of the following condition using the half-melting injection molding machine (form:JLM-450E, Japan Steel Works Make) shown in drawing 4 . In addition, among drawing, one is a cylinder, it extrudes inside, and has a screw 2 and metal mold 4 is equipped with the high-speed injection device 3 by the back end at the nose of cam. Around a cylinder 1, the heating heater 5 is arranged at the predetermined spacing, and heating melting of the material supplied from the hopper 6 formed in the entrance of a cylinder 1 is carried out one by one. First, the raw material chip cut so that a major axis might be set to about 5mm from an ingot is inserted in a hopper. This chip is supplied for every shot in a cylinder by the feeder, and is ahead sent in the measurement process which retreats while a screw rotates. The temperature control of the cylinder is divided and carried out to eight zones, the temperature up of the chip is gradually carried out during conveyance, and the half-melting status is reached in the pars anterior. In the latest nozzle section, temperature is made low, a freezing plug is formed, defluxion of a molten metal is prevented, and it has become constructing. Moreover, Ar gas is passed in order to prevent oxidization in a cylinder and a hopp r. a screw carries out high-speed advance of the molten metal sent ahead — metal mold — inside, it is high-speed-filled up and the rapid freezing is carried out, and it becomes mold goods and is taken out After a mold aperture (drawing 4 (B)), the rough-forging material W1 by which

injection molding was carried out is taken out, is installed in a forging upper-and-lower-sides type (drawing 4 (C)), and after forging (drawing 4 (D)), the mold aperture of it is carried out and it takes out a forging W2 (drawing 4 (E)). As for this forging W2, T6 processing is performed as finishing after that. although T6 suitable processing serves as 4s levers in this invention at material composition — generally — they are high-temperature-aging::170-230 degree C, 4 - 16 hours for solution treatment:380-420 degree C, 10 to 24 hours

[0014]

[Table 1]

Magnesium alloy composition (unit:weight %)

aluminum Zn Mn Fe Si Cu nickel Mg alloy A 8.8 0.45 0.25 0.001 0.03 0.004 0.001 Bal. B 7.2 0.48 0.25 0.001 0.03 0.004 0.001 Bal. [0015]

[Table 2] Injection-molding condition injection pressure 80MPa injection speed 2m / sec die temperature 180 degrees C [0016] A Magnesium alloy is cut and is invested in the shape of a chip, and nothing and a hopper. The rate (solid phase/liquid phase) of solid phase within a cylinder was adjusted at the heating temperature in a cylinder, it was adjusted so that the rate of solid phase before injection might become 0% from 25%, and it performed injection molding. When the rate of solid phase exceeds 20%, it is in the inclination which a micro cavity increases (a comparison contrast, notes:view 6, and the drawing 7 are related with an example 6 in the microphotography of 4% of the rates of solid phase of drawing 6 , and the microphotography of 25% of the rates of solid phase of drawing 7), and it is thought that a moldability is checked. On the other hand, the perfect melting status (0% of the rates of solid phase), nothing, and dies-casting molding were performed for alloy A. a test piece with a diameter [from an injection-molding article / in / as shown in drawing 5 / the various rates of solid phase /, and dies-casting mold goods / of 15cm], and a height of 30cm — preparing (drawing 5 (A)) — the press upper and lower sides — metal mold — it sets until a crack occurs on a front face, equipping in between [H1] (drawing 5 (B)), heating a test piece at 350 degrees C of test temperatures, and holding a test temperature If up Shimokane type distance at that time is set to H2, the rate of a marginal **** lump is computable with the following formula (I).

[Equation 1]

Rate [of a marginal **** lump] = (H1-H2) / H 1x100 (%) (I)

A result is shown in drawing 1 . The direction of the fraction which was the liquid phase becomes detailed [the material property after injection molding], and plastic-working nature is good. Although the moldability gets worse gradually in connection with the increase in the rate of solid phase, if 20% is exceeded, a decreasing rate will become large abruptly. Moreover, even when the moldability with dies-casting material was compared and all are changed into the melting status (0% of the rates of solid phase), it turns out that the direction of the material of injection molding is excellent in a moldability. Dies-casting material is considered because many detailed pores are included.

[0017] The relation between solid phase particle size and a moldability was considered about alloy A. Consequently, if solid phase particle size exceeds 300 micrometers, the deformation with the fraction which was the liquid phase will become uneven, and aggravation of a moldability will happen abruptly. It is a general inclination that this solid phase particle size is related to the rate of solid phase, and solid phase particle size also increases in connection with increase of the rate of solid phase. In addition, solid phase particle size is measured by image-analysis equipment.

[0018] Subsequently, the relation between the content of the aluminum in an injection-molding material alloy and a moldability was investigated in 6% of the rates of solid phase, and 15% about the Magnesium alloy (examples 1-6) of the following composition. Consequently, mean solid phase particle size is about 40 micrometers, and it turns out that the direction of 6% of the rates of solid phase is excellent in a moldability collectively. Moreover, when th content of aluminum exceeded 8.5%, the rate of a marginal **** lump was less than 70%, and it turns out that a moldability gets worse. A result is shown in drawing 3 .

[0019]

[Table 3]

wt%

	Al	Zn	Mn	Si	Ni	Cu	Fe	Mg
実施例1	4.2	0.50	0.20	0.04	0.001	0.005	0.001	残
実施例2	6.2	0.48	0.25	0.03	0.001	0.004	0.001	残
実施例3	6.8	0.45	0.22	0.04	0.001	0.005	0.001	残
実施例4	7.3	0.47	0.25	0.03	0.001	0.004	0.001	残
実施例5	8.4	0.42	0.23	0.03	0.001	0.005	0.001	残
実施例6	9.2	0.48	0.23	0.03	0.001	0.005	0.001	残

[0020] Next, the result about the effect of T6 processing is shown in drawings 8 -10. By processing after [forging] T6, an intensity and ductility improve by leaps and bounds compared with what forged injection-molding material as it was.

[0021] Although various effects were checked about the Magnesium alloy above, the relation between the rate of solid phase and a moldability is a phenomenon peculiar to the light metal alloy which carries out injection molding by the half-melting injection-molding method, and can apply this invention technique to the light metal alloy which contains magnesium and aluminum widely.

[0022]

[Effect of the Invention] Since the moldability of the injection-molding material of a light metal alloy can be raised according to this invention as explained above, the rough-forging mold goods with a sufficient moldability can be obtained, and the last forging can be manufactured by molding at one process. Therefore, the number of forging processes can be reduced as compared with the case where the conventional continuous casting material is forged. Furthermore, as compared with dies-casting material, since there are few cavities, forging is possible. Compared with a forging [injection-molding material]-as it was thing, an intensity and ductility can be raised by leaps and bounds with T6 heat treatment further again.

[Translation done.]

DESCRIPTION OF DRAWINGS

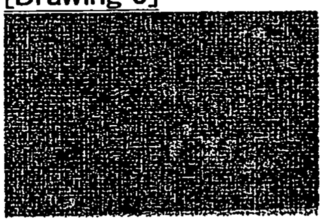
[Brief Description of the Drawings]
[Drawing 1] It is the graph which shows the relation between the rate of solid phase, and a moldability in injection molding of a Magnesium alloy.
[Drawing 2] It is the graph which shows the relation of the solid phase particle size and the moldability in half-melting injection molding of a Magnesium alloy.
[Drawing 3] It is the graph which shows the relation between an aluminum content and a moldability in half-melting injection molding of a Magnesium alloy.
[Drawing 4] It is the flow sheet which shows the process of this invention technique.
[Drawing 5] It is the flow sheet which shows the rate measurement process of a marginal **** lump of this invention material.
[Drawing 6] It is the microphotography in which the organization of half-melting injection-molding material (4% of the rates of solid phase) which injection molded by this invention technique is shown.
[Drawing 7] It is the microphotography in which the organization of half-melting injection-molding material (25% of the rates of solid phase) which injection molded by this invention technique is shown.
[Drawing 8] It is the graph which shows the relation of **** elongation and T6 heat treatment.
[Drawing 9] It is the graph which shows the relation between the tensile strength of T6 material, and the existence of forging.
[Drawing 10] It is the graph which shows the relation between the elongation of T6 material, and the existence of forging.
[Description of Notations]
1 A cylinder, 2 A screw, 3 A high-speed injection device, 4 Metal mold, 5 A heating heater, 6 Hopper.

[Translation done.]

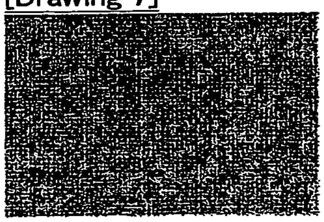
* NOTICES *

DRAWINGS

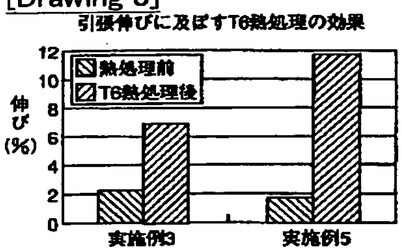
[Drawing 6]



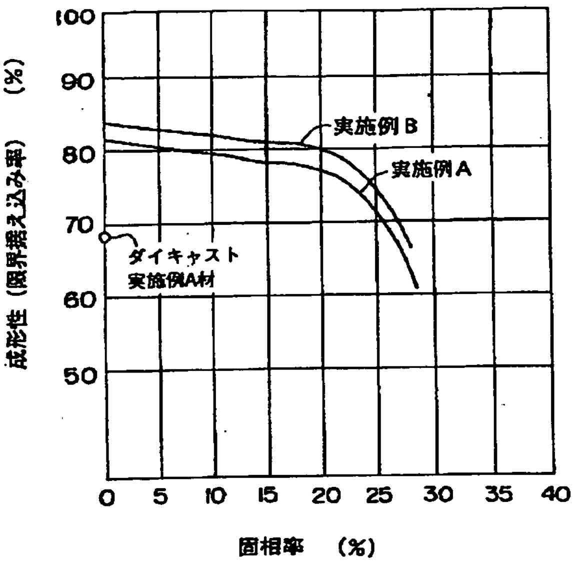
[Drawing 7]



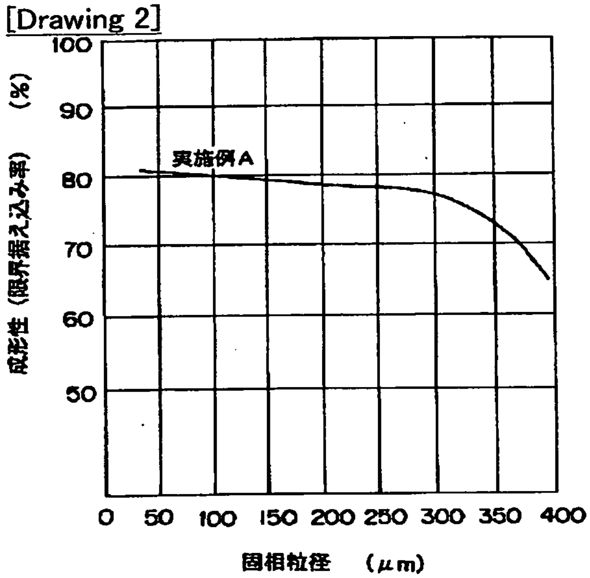
[Drawing 8]



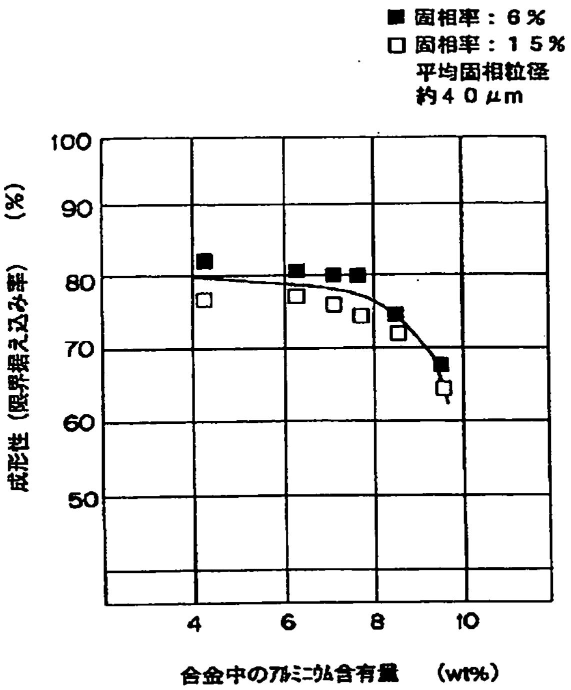
[Drawing 1]



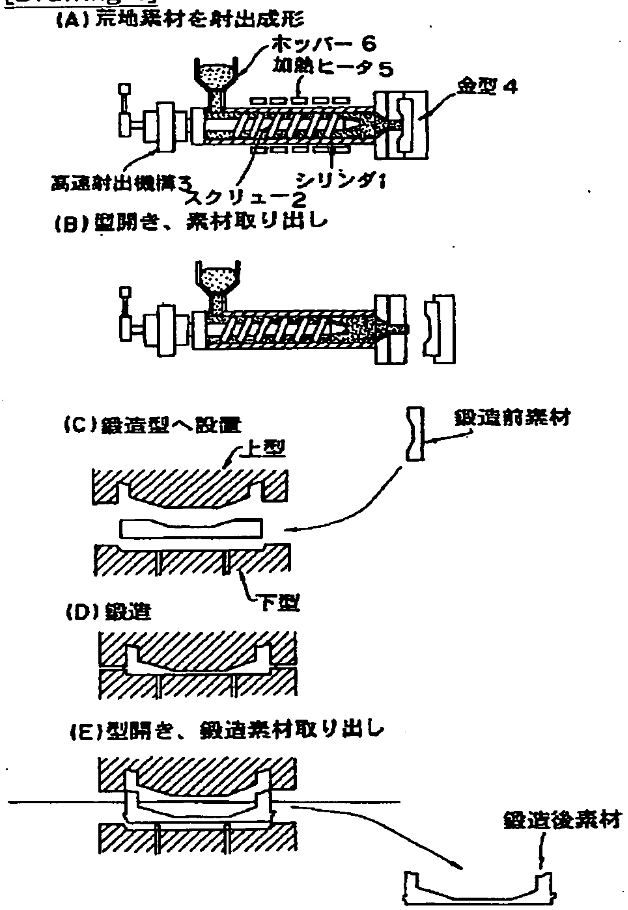
[Drawing 2]



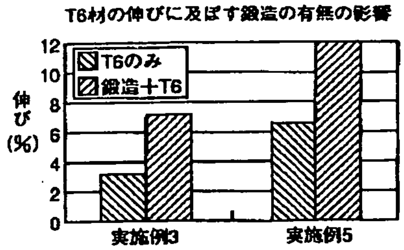
[Drawing 3]



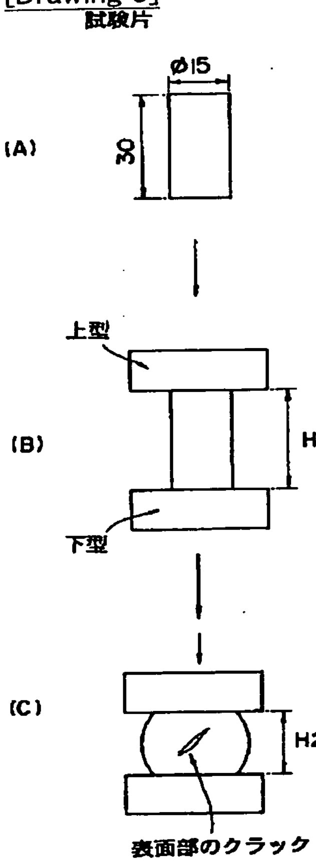
[Drawing 4]



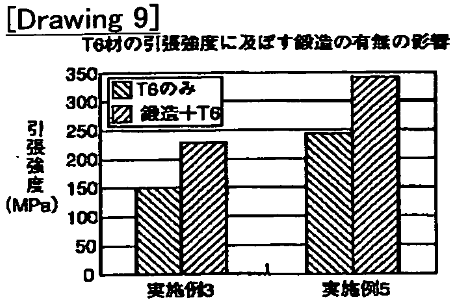
[Drawing 10]



[Drawing 5]



[Drawing 9]



[Translation done.]

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		５０３			５０３Ｌ
	23/02			23/02	

審査請求　未請求　請求項の数８　ＯＬ　（全 ６ 頁）　最終頁に続く

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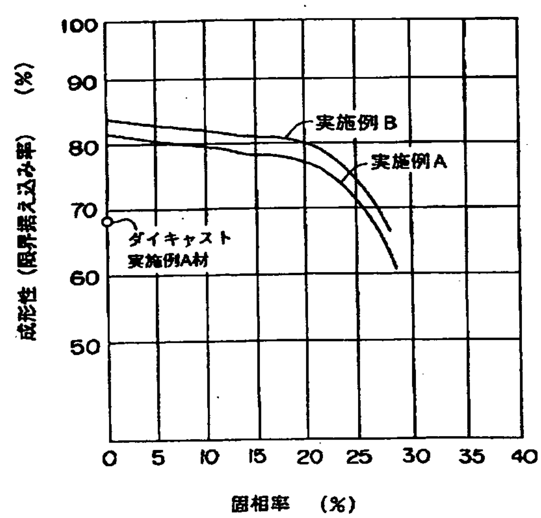
最終頁に続く

(54)【発明の名称】　軽金属合金塑性加工用素材および塑性加工材の製造方法

(57)【要約】

【課題】　優れた塑性加工性を有する軽金属合金およびその製造方法を提供すること。

【解決手段】　軽金属を母材とし、固相率２０％以下で射出成形するもので、７０％以上の限界据え込み率を有する成形性に優れる軽金属合金射出成形材である。この射出成形材は一工程での鍛造により最終成形品とすることができる。



【特許請求の範囲】

【請求項１】　軽金属合金を固相率２０％以下の固相／液相が共存する半溶融状態あるいは融点直上の温度で溶融状態とした後、射出成形することを特徴とする軽金属合金塑性加工用素材の製造方法。

【請求項２】　軽金属合金を固相率２０％以下の固相／液相が共存する半溶融状態あるいは母材融点直上の温度で溶融状態とした後、射出成形し、塑性加工することを特徴とする軽金属合金塑性加工用素材の製造方法。

【請求項３】　さらに、熱処理することを特徴とする請求項１または２記載の製造方法。

【請求項４】　半溶融状態での固相平均粒径が３００μm以下である請求項１～３のいずれかに記載の製造方法。

【請求項５】　塑性加工が鍛造加工である請求項２記載の製造方法。

【請求項６】　鍛造加工温度が４００℃以下である請求項５記載の製造方法。

【請求項７】　軽金属合金が母材をマグネシウムとし、合金成分としてアルミニウム４～９.５重量%を含有する請求項１～６のいずれかに記載の製造方法。

【請求項８】　熱処理条件がＴ６処理である請求項３記載の製造方法。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、軽金属合金、特に合金成分としてアルミニウムを含有するマグネシウム合金の塑性加工用素材およびそれを用いた塑性加工材の製造方法に関する。

【０００２】

【従来の技術】アルミニウムまたはマグネシウムを母材とする軽金属合金、特にアルミニウムを合金成分とするマグネシウム合金は軽量でかつ鍛造等の塑性加工を施すことにより所定の機械的強度を確保できる素材として注目されている。しかしながら、この種軽金属合金は熱ひけが良いため、重力鋳造では鋳造温度を高くしなければ、湯流れが悪化し、健全な（鋳巣の少ない）鋳物が得られない。ところが、鋳造温度が高いと、冷却速度が小さくなるため、材料組織が粗くなり、成形性が悪く、加工率が大きくとれない。そのため、要求形状の成形品を得るために、何度も加工を繰り返す必要がある。他方、ダイキャストでは微細な組織が得られるが、金型内に溶湯を霧状に圧力注入するため、微小な空孔が鋳物内に多く含まれ、ガス欠陥となり、良好な鍛造加工材が得られない。

【０００３】

【発明が解決しようとする課題】アルミニウムおよびマグネシムを母材とする軽金属合金においてかかる鍛造加工性を向上させるには、ダイキャスト以外の方法で微細な組織を有する鋳造材を得る必要がある。そこで、鋭意研究の結果、半溶融射出成形法を採用し、その固相率または固相粒径を調整しながら射出成形すると、成形性のいい素材が得られ、射出成形材を一発鍛造により所望の成形品を得ることができることを見出した。

【０００４】すなわち、本発明の第１の目的は、塑性加工性に優れる素材を製造する半溶融射出成形方法を提供することにある。本発明の第２の目的は塑性加工性に優れる素材を射出成形し、一工程での鍛造により鍛造成形品を製造する方法を提供することにある。

【０００５】

【課題を解決するための手段】上記目的を達成するために、本発明は軽金属合金を固相率２０％以下の固相／液相が共存する半溶融状態あるいは母材融点直上の温度で溶融状態とした後、射出成形することを特徴とする軽金属合金塑性加工用素材の製造方法にある。

【０００６】本発明によれば、固相率を２０％以下とすることにより限界据え込み率７０％以上の良好な成形性が得られることが見い出されている（図１参照）。半溶融状態だけでなく、すべてが溶融状態にある場合でも母材融点直上で射出成形を行うようにすると、ダイキャストより成形性が優れる素材を得ることができることが見い出されている。

【０００７】固相率を２０％以下とする理由は固相率が低いほど半溶融状態における固相平均粒径が小さくなり、その固相平均粒径が小さい程射出成形材の成形性が向上するからである。固相平均粒径からみれば、３００μm以下であるのが好ましく、それを境に限界据え込み率は急激に低下することが見出されている（図２参照）。

【０００８】上記射出成形物が固相率を２０％以下の射出成形で良好な成形性を示す理由は定かでないが、半溶融状態での射出成形により液相部は微細組織となり、鍛造時の成形性は良好であるが、固相部はその形態を保持しやすい。したがって、固相部分の割合が多すぎたり、粒径が大き過ぎると、成形性に不均一性が生じ、全体としての成形性を低下させることが関与するものと思われる。

【０００９】本発明によって成形される素材は塑性加工性、すなわち、鍛造加工性が向上するので、鍛造加工を４００℃以下で行うことができる。それにより、強度が向上する。また、射出成形に加え、１回のみの鍛造でネットシェイプの製品ができるので、複数の鍛造型や切削加工が不要となり、経済性に優れるという利点を得ることができる。

【００１０】軽金属合金としては、母材がマグネシウムであって、合金成分としてアルミニウム４～９.５重量%を含有するものに本発明方法を適用するのが好ましい。４重量%未満では熱処理による機械的強度の増強が望めず、９．５重量%を越えると、成形性（限界据え込み率）の低下が著しいからである（図３参照）。

【0011】本発明で得られる軽金属合金は熱処理条件としてT6熱処理（溶体化処理と人工時効化処理）を行うのが好ましい。その結果、鍛造時の残留歪が除去され、製品形状の経年変化が起こらず、さらに優れた延性が付与される。

【0012】本発明によれば、連続鋳造より成形性に優れる射出成形材を提供することができる。射出成形材は荒地形状のビレットであるため、一工程での鍛造により最終製品とすることができ、鍛造工程数を削減することができる。また、鋳巣の少ない健全な組織が得られるので、歩留まりの向上が図れる。

【0013】

【発明の実施の形態】以下、本発明の実施の形態について、図面を参照しながら説明する。以下の組成を有するマグネシウム合金A、Bを用意し、図4に示す半溶融射出成形機（型式：JLM−450E，株式会社日本製鋼所製）を用いて次の条件下に射出成形を行った。なお、図中、1はシリンダで、内部に押し出しスクリュー2を備え、後端には高速射出機構3を、先端には金型4が装着されている。シリンダ1の周囲には加熱ヒータ5が所定の間隔で配置され、シリンダ1の入り口に設けたホッパー6から投入される材料を順次加熱溶融するようになっている。まず、インゴットより長軸が5mm程度にな＊＊るように切削された原料チップをホッパに挿入する。このチップは、フィーダによりシリンダ内に1ショット毎に供給され、スクリューが回転しながら後退する計量工程において前方に送られる。シリンダは8つのゾーンに分割され温度制御されており、チップは搬送中に徐々に昇温し、前部において半溶融状態に達する。最先端のノズル部では温度を低くして凝固プラグを形成し、溶湯の流出を防止するしくみになっている。また、シリンダとホッパ内には酸化を防止するために、Arガスを流している。前方に送られた溶湯は、スクリューが高速前進することにより金型内に高速充填、急速凝固し成形品となって取り出される。射出成形された荒地素材W1は型開き後（図4（B））、取り出し、鍛造上下型内に設置し（図4（C））、鍛造後（図4（D））、型開きじて鍛造品W2を取り出す（図4（E））。この鍛造品W2はその後仕上げとしてT6処理が施される。本発明においては適切なT6処理は、材料組成によってことなるが、大体溶体化処理：380〜420℃、10〜24時間、時効硬化処理：：170〜230℃、4〜16時間である。

【0014】

【表1】

マグネシウム合金組成

（単位：重量%）

	Al	Zn	Mn	Fe	Si	Cu	Ni	Mg
合金A	8.8	0.45	0.25	0.001	0.03	0.004	0.001	Bal.
B	7.2	0.48	0.25	0.001	0.03	0.004	0.001	Bal.

【0015】

【表2】射出成形条件

射出圧	80MPa
射出速度	2m／sec
金型温度	180℃

【0016】マグネシウム合金は切削して切粉状となし、ホッパーに投入される。シリンダ内での固相率（固相／液相）はシリンダー内の加熱温度で調整し、射出前の固相率が25%から0%となるように調整し、射出成形を行った。固相率が20%を越えるとミクロな鋳巣が増加する傾向にあり（図6の固相率4%の顕微鏡写真と図7の固相率25%の顕微鏡写真を比較対照、注：図※※6、図7は実施例6に関するものである）、成形性を阻害するものと思われる。他方、合金Aを完全溶融状態（固相率0%）となし、ダイキャスト成形を行った。図5に示すように、種々の固相率における射出成形品とダイキャスト成形品から直径15cm、高さ30cmの試験片を用意し（図5（A））、プレス上下金型間H1に装着し（図5（B））、試験温度350℃に試験片を加熱し、試験温度を保持しつつ、表面にクラックが発生するまで据え込む。そのときの上下金型距離をH2とすると、次式（I）により限界据え込み率が算出できる。

【数1】

限界据え込み率＝（H1−H2）／H1×100（%）　　（I）

結果を図1に示す。射出成形後の材料特性は液相であった部分の方が微細となり、塑性加工性はよい。固相率の増加に伴って、成形性は次第に悪化していくが、20%を越えると、低下率が急激に大きくなる。また、ダイキャスト材との成形性を比較すると、全て溶融状態（固相率0%）にした場合でも射出成形の素材の方が成形性に優れていることが分かった。ダイキャスト材は微細なポアを多く含むためと考えられる。

【0017】合金Aについて固相粒径と成形性との関係を検討した。その結果、固相粒径が300μmを越えると、液相であった部分との変形が不均一となり、成形性の悪化が急激に起こる。この固相粒径は固相率と関係しており、固相率の増大に伴い、固相粒径も増大するのが一般的傾向である。なお、固相粒径は画像解析装置により測定される。

【0018】次いで、以下の組成のマグネシウム合金（実施例1〜6）について射出成形素材合金中のアルミニウムの含有量と成形性との関係を固相率6%と15%

において調査した。その結果、平均固相粒径は約４０μｍであって、全体として固相率６％の方が成形性に優れることが分かった。また、アルミニウムの含有量が８．５％を越えると、限界据え込み率は７０％を下回り、成＊形性が悪化することが分かった。結果を図３に示す。

【００１９】

【表３】

ｗｔ％

	Ａｌ	Ｚｎ	Ｍｎ	Ｓｉ	Ｎｉ	Ｃｕ	Ｆｅ	Ｍｇ
実施例１	4.2	0.50	0.20	0.04	0.001	0.005	0.001	残
実施例２	6.2	0.48	0.25	0.03	0.001	0.004	0.001	残
実施例３	6.8	0.45	0.22	0.04	0.001	0.005	0.001	残
実施例４	7.3	0.47	0.25	0.03	0.001	0.004	0.001	残
実施例５	8.4	0.42	0.23	0.03	0.001	0.005	0.001	残
実施例６	9.2	0.48	0.23	0.03	0.001	0.005	0.001	残

【００２０】次に、Ｔ６処理の効果についての結果を図８～１０に示す。鍛造後Ｔ６処理することにより、射出成形材をそのまま鍛造したものに比べて飛躍的に強度・延性が向上する。

【００２１】以上マグネシウム合金について種々の効果を確認したが、固相率と成形性との関係は半溶融射出成形法で射出成形する軽金属合金に特有の現象であり、本発明方法は広くマグネシウムとアルミニウムを含有する軽金属合金に適用可能である。

【００２２】

【発明の効果】以上説明したように本発明によれば、軽金属合金の射出成形材の成形性を向上させることができるので、成形性の良い荒地成形品を得ることができ、一工程での成形により最終鍛造品を製造することができる。したがって、従来の連続鋳造材を鍛造する場合に比して鍛造工程数を低減することができる。さらに、ダイキャスト材に比して鋳巣が少ないので鍛造ができる。さらにまた、Ｔ６熱処理により、射出成形材をそのまま鍛造したのものに比べて飛躍的に強度・延性を向上させることができる。

【図面の簡単な説明】

【図１】　マグネシウム合金の射出成形における固相率と成形性の関係を示すグラフである。※

※【図２】　マグネシウム合金の半溶融射出成形における固相粒径と成形性との関係を示すグラフである。

【図３】　マグネシウム合金の半溶融射出成形におけるアルミニウム含有量と成形性の関係を示すグラフである。

【図４】　本発明方法の工程を示すフローシートである。

【図５】　本発明素材の限界据え込み率測定工程を示すフローシートである。

【図６】　本発明方法で射出成形した半溶融射出成形材（固相率４％）の組織を示す顕微鏡写真である。

【図７】　本発明方法で射出成形した半溶融射出成形材（固相率２５％）の組織を示す顕微鏡写真である。

【図８】　引張伸びとＴ６熱処理の関係を示すグラフである。

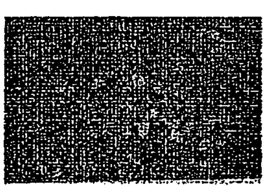
【図９】　Ｔ６材の引張強度と鍛造の有無の関係を示すグラフである。

【図１０】　Ｔ６材の伸びと鍛造の有無の関係を示すグラフである。

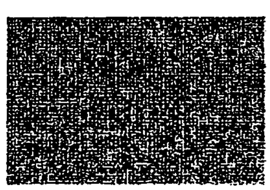
【符号の説明】

１　シリンダ、２　スクリュー、３　高速射出機構、４　金型、５　加熱ヒータ、６　ホッパー。

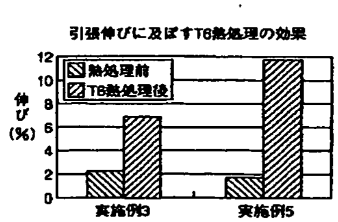
【図６】



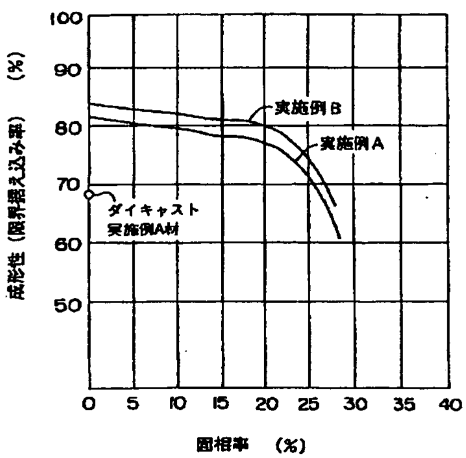
【図７】



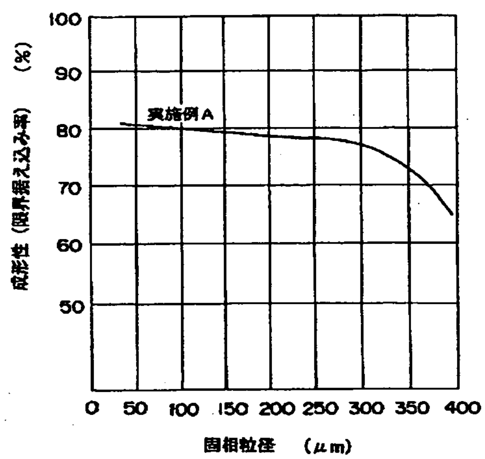
【図８】



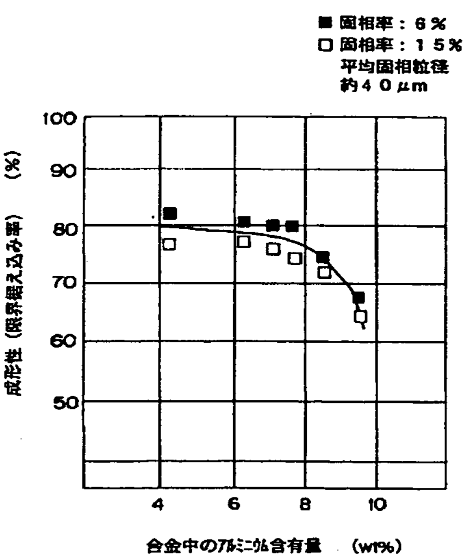
【図1】



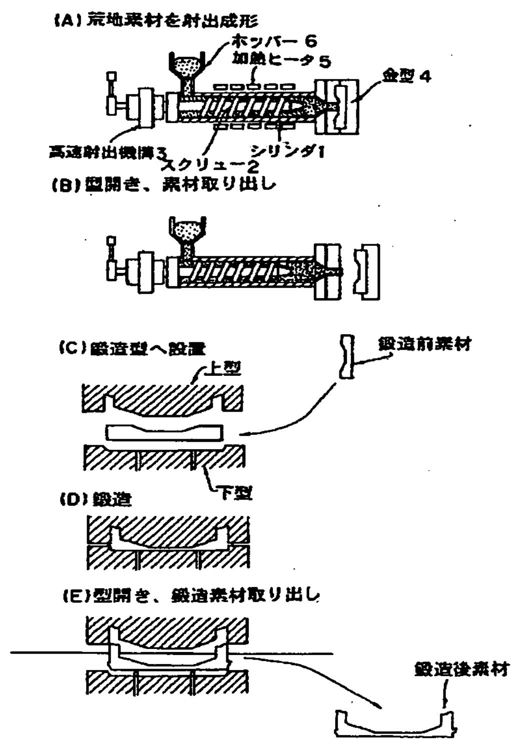
【図2】



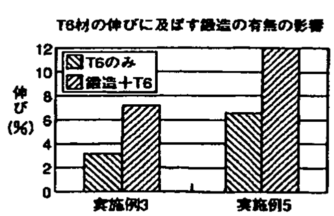
【図3】



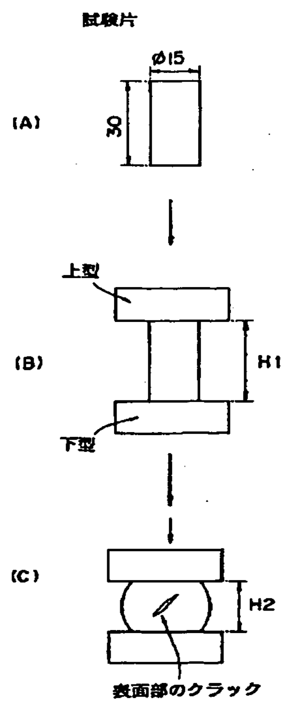
【図4】



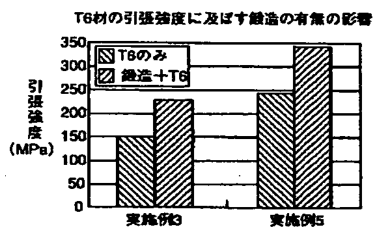
【図10】



【図5】



【図9】



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